

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark
Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year)

18 May 1999 (18.05.99)

International application No.

PCT/GB98/02829

Applicant's or agent's file reference

International filing date (day/month/year)

23 September 1998 (23.09.98)

Priority date (day/month/year)

23 September 1997 (23.09.97)

Applicant

BLACKET, Stuart, Edmund

1. The designated Office is hereby notified of its election made:

☒

in the demand filed with the International Preliminary Examining Authority on:

21 April 1999 (21.04.99)

☐

in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

☐

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

S. Mafla

Telephone No.: (41-22) 338.83.38

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PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 98/ 02829	International filing date (day/month/year) 23/09/1998	(Earliest) Priority Date (day/month/year) 23/09/1997
Applicant HENROB LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

- ☒ Certain claims were found unsearchable (see Box I).
- ☐ Unity of invention is lacking (see Box II).
- ☐ The international application contains disclosure of a **nucleotide and/or amino acid sequence listing** and the international search was carried out on the basis of the sequence listing
 - ☐ filed with the international application.
 - ☐ furnished by the applicant separately from the international application,
 - ☐ but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
 - ☐ Transcribed by this Authority

- With regard to the **title**,
 - ☐ the text is approved as submitted by the applicant.
 - ☒ the text has been established by this Authority to read as follows:

SHEET JOINING METHOD AND APPARATUS AND A RIVET FOR USE IN THE METHOD

- With regard to the **abstract**,
 - ☐ the text is approved as submitted by the applicant.
 - ☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this International Search Report, submit comments to this Authority.

- The figure of the **drawings** to be published with the abstract is:

Figure No. 7

- ☐ as suggested by the applicant.
- ☒ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.
- ☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 98/02829

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 14, 18, 19
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

It is not possible to understand, which combination of physical features it is desired to protect by claims 14 and 19, or which combination of method steps by claim 18 (Article 6 PCT). Furthermore, claims 18 and 19 would not appear to conform to Rule 6.2(a) PCT.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB 98/02829

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A method and apparatus for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location. The sheets are superimposed and placed in a fastener setting and sheet deforming assembly. The assembly is then operated to set a fastener into the sheet and to deform the sheets out of their planes around the predetermined locations. The sheets may be deformed before the fastener is set, after the fastener is set, or simultaneously with setting of the fastener. Sheet deformation may be achieved using appropriate clamping arrangements or by providing recesses into which the sheets are deformed during the course of rivet insertion. The invention also relates to a rivet for use in the method.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 98/02829

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B21J15/02 B21D39/03 F16B19/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B21J F16B B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 958 389 A (STANDARD PRESSED STEEL CO.) 25 May 1976	16
Y	see page 1, right-hand column, line 21-37; figure 2	13

X	DE 25 46 214 A (FURMA MANUFACTURING CO) 28 April 1977	17
	see figures 1-5	

X	US 2 245 933 A (MOORE, N.B.) 17 June 1941	1-12, 15
Y	see column 1, line 35-46; figures 1-3	13

☐

Further documents are listed in the continuation of box C.

☒

Patent family members are listed in annex.

* Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

& document member of the same patent family

Date of the actual completion of the international search

18 January 1999

Date of mailing of the international search report

27. 01. 99

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Ash, R

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 98/02829

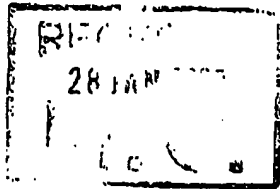
Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3958389 A	25-05-1976	CA 930991 A	31-07-1973
		CH 493750 A	15-07-1970
		CH 500391 A	15-12-1970
		CH 507458 A	15-05-1971
		DE 1910377 A	25-09-1969
		FR 2003010 A	07-11-1969
		GB 1266893 A	15-03-1972
		GB 1266894 A	15-03-1972
		IE 33278 B	15-05-1974
		NL 6903182 A	03-09-1969
		SE 364349 B	18-02-1974
		US 3551015 A	29-12-1970
DE 2546214 A	28-04-1977	NONE	
US 2245933 A	17-06-1941	NONE	

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

ALMAN, P.
Marks & Clerk
Sussex House
83-85 Mosley Street
Manchester M2 3LG
GRANDE BRETAGNE



PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing
(day/month/year) 25. 01. 00

Applicant's or agent's file reference
PJA/C088179PWO ✓

IMPORTANT NOTIFICATION

International application No.
PCT/GB98/02829

International filing date (day/month/year)
23/09/1998

Priority date (day/month/year)
23/09/1997

Applicant
HENROB LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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D-80298 Munich
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Authorized officer

Brandl, M.
Tel. +49 89 2399-2926



PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PJA/C088179PWO	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/APEA/416)	
International application No. PCT/GB98/02829	International filing date (day/month/year) 23/09/1998	Priority date (day/month/year) 23/09/1997
International Patent Classification (IPC) or national classification and IPC B21J15/02		
Applicant HENROB LIMITED et al.		

1. This International preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 5 sheets, including this cover sheet.

- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 21/04/1999	Date of completion of this report 25. 01. 00
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Ash, R Telephone No. +49 89 2399 2361 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB98/02829

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-6 as originally filed

Claims, No.:

1-16 as received on 08/10/1999 with letter of 08/10/1999

Drawings, sheets:

1/3-3/3 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☒ the claims, Nos.: 17-19
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:**III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability**

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

- ☐ the entire international application.
☒ claims Nos. 15.

because:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB98/02829

- ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):
- ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
- ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.
- ☒ no international search report has been established for the said claims Nos. 15.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Yes: Claims 1,14,16
	No: Claims 2-13
Inventive step (IS)	Yes: Claims
	No: Claims 1-14,16
Industrial applicability (IA)	Yes: Claims 1-14,16
	No: Claims

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB98/02829

1. In accordance with Rule 70.2(d) PCT no opinion will be given with regard to whether the subject-matter of claim 15 meets Article 33 PCT, because the subject-matter of this claim has not been searched. None of the originally filed claims related to a rivet which comprises a head, the thickness of which increases **continually** in the radially outward direction.
2. The broadest claim is claim 16, so this will be addressed first. The subject-matter of this claim lacks novelty (Article 33(2) PCT).

From DE-A-2 546 214 (=D2), Figures 1 to 5, a method of joining two or more sheet materials (32, 33) with a fastener (34) is known, wherein the sheet materials are deformed by abutment with a die surface (25) to form an annular deformation engaged between a head and a free end of a stem or shank of the fastener (see Figure 5).

3. Independent claim 1 does not include any new subject-matter (Article 33(2) PCT).

Document US-A-2 245 933 (=D3) discloses a

A method for joining together two or more superimposed generally planar sheets (3,4) by setting a fastener (1) in engagement with the sheets at a predetermined location, wherein the superimposed planar sheets are placed in a fastener setting and sheet deforming assembly, and the assembly is operated to set a fastener into the sheets and to deform all the sheets out of their planes around the predetermined location (see column 1, lines 35 to 46).

4. Dependent claims 2 to 13 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT with respect to novelty and/or inventive step (Articles 33(2) and (3) PCT).
- 4.1 The additional features of claims 2 to 12 do introduce anything other than simple method steps, which the skilled man would perform at his discretion, without an inventive step being required.

INTERNATIONAL PRELIMINARY

International application No. PCT/GB98/02829

EXAMINATION REPORT - SEPARATE SHEET

- 4.2 Document **US-A-3 958 389 (=D1)** discloses on page 1, right-hand column, lines 21 to 37 the advantages of providing a recess under the head of the rivet. For the skilled man starting from D3 it would be obvious to apply the teaching of D1 to realise these advantages. In this way he would arrive at the subject-matter of claim 13 without exercising an inventive step.
5. Independent claim 14 lacks novel subject-matter compared to D3 (Article 33(2) PCT).
- 5.1 From D3, the following features are known in combination:
- An apparatus suitable for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location, the apparatus comprising an assembly which is operative to receive superimposed planar sheets and to set a fastener in engagement with the sheets and to deform all the sheets around the predetermined location out of their planes either before, during or after fastener setting.
6. The claims meet neither Rule 6.2(b) nor 6.3(b) PCT.
7. The description does not meet Rule 5.1(a)(ii) PCT, because documents D1 to D3 are not cited therein.

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430 Rec'd PCT/PTO 23 MAR 2000

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CLAIMS

1. A method for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location, wherein the superimposed planar sheets are placed in a fastener setting and sheet deforming assembly, and the assembly is operated to set a fastener into the sheets and to deform all the sheets out of their planes outside the predetermined location.
2. A method according to claim 1, wherein the sheets are deformed before the fastener is set.
3. A method according to claim 2, wherein the sheets are clamped together before the fastener is set.
4. A method according to claim 3, wherein the sheets are clamped together until the fastener has been set.
5. A method according to claim 3, wherein the sheets are unclamped before the fastener is set.
6. A method according to claim 3, 4 or 5 wherein the sheets are clamped together between a clamping member and a die shaped such that the sheets are deformed between the clamping member and the die.
7. A method according to claim 2, 3, 4, 5 or 6 wherein the sheets are supported around the predetermined location by a support surface defining a recess into which the sheets are deformed by a head portion of the fastener.
8. A method according to claim 1, wherein the sheets are deformed after the fastener is set.

9. A method according to claim 8, wherein the sheets to be deformed are clamped between a clamping member and a die shaped such that the sheets are deformed between the clamping member and the die.
10. A method according to claim 1, wherein the sheets are deformed and the fastener is set simultaneously.
11. A method according to claim 10, wherein the sheets are deformed by supporting the sheets on a die defining a recess extending around the predetermined location, a head portion of the fastener driving the sheets into the recess when the fastener is set.
12. A method according to claim 11, wherein the sheets are clamped against the surface of the die outside the said recess during the setting of the fastener.
13. A method according to claim 11 or 12, wherein the fastener head increases in thickness towards its periphery so as to define a convex surface facing the recess formed in the die.
14. An apparatus for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location, the apparatus comprising an assembly which is operative to receive superimposed planar sheets and to set a fastener in engagement with the sheets and to deform all the sheets outside the predetermined location out of their planes either before, during or after fastener setting.
15. A rivet for use in accordance with the method of claim 1, comprising a head the thickness of which increases continually in the radially outwards direction to define a convex surface beneath the head.

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16. A method for joining two or more sheet materials with a fastener, wherein the sheet materials are deformed by abutment with a die surface to form an annular deformation engaged between a head and a free end of a stem or shank of the fastener.

AMENDED SHEET

(51) International Patent Classification ⁶ : B21J 15/02, B21D 39/03, F16B 19/08	A1	(11) International Publication Number: WO 99/15288
		(43) International Publication Date: 1 April 1999 (01.04.99)

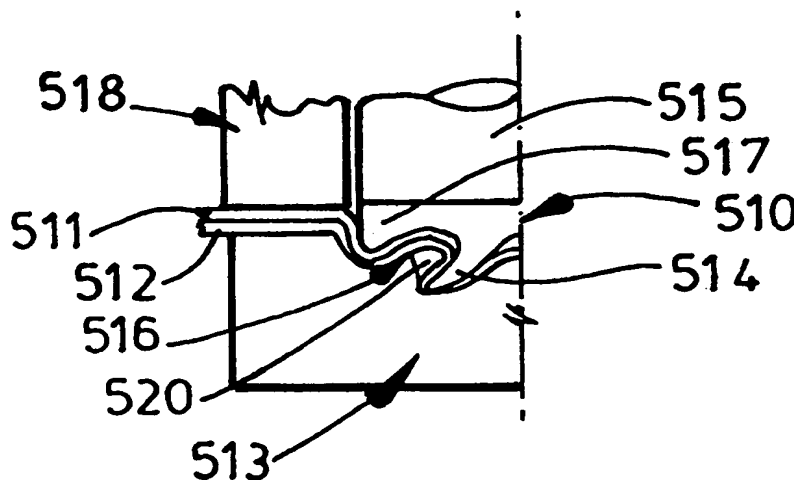
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published *With international search report.
Before the expiration of the time limit for amending the
claims and to be republished in the event of the receipt of
amendments.*

(54) Title: SHEET JOINING METHOD AND APPARATUS AND A RIVET FOR USE IN THE METHOD

(57) Abstract

A method and apparatus for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location. The sheets are superimposed and placed in a fastener setting and sheet deforming assembly. The assembly is then operated to set a fastener into the sheet and to deform the sheets out of their planes around the predetermined locations. The sheets may be deformed before the fastener is set, after the fastener is set, or simultaneously with setting of the fastener. Sheet deformation may be achieved using appropriate rivet insertion. The invention



may be achieved using appropriate clamping arrangements or by providing recesses into which the sheets are deformed during the course of rivet insertion. The invention also relates to a rivet for use in the method.

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SHEET JOINING METHOD AND APPARATUS AND A RIVET FOR USE IN THE METHOD

This invention relates to an improved sheet joining method and apparatus.

When joining two thin metal sheets together with, e.g. rivets, there is often difficulty in achieving sufficient shear load strength. It is believed that the shear load strength can be increased by the order of 15% when a blind rivet is applied in a known manner to pre-dimpled sheets, that is sheets in which dimples have been pressed around holes formed to receive blind rivets. In many applications however it is not practical to press dimples into sheets before they are secured together.

It is an object of the present invention to provide a joining method and apparatus capable of providing increased joint shear load strength.

According to the present invention, there is provided a method for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location, wherein the superimposed planar sheets are placed in a fastener setting and a sheet deforming assembly, and the assembly is operated to set a fastener into the sheet and to deform the sheets out of their planes around the predetermined location.

The term "fastener" is used herein to include rivets, screws and the like.

The invention also provides an apparatus for carrying out the above method.

The invention further provides an apparatus for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location, the apparatus comprising an assembly which is operative to receive superimposed planar sheets and to set a fastener in engagement with the sheets and to deform the sheets around the predetermined location out of their planes either before, during or after fastener setting.

The invention further provides a rivet for use in accordance with the above mentioned method, comprising a head the thickness of which increases in the radially outwards direction to define a convex surface beneath the head.

The invention further provides a method for joining two or more sheet materials with a fastener, wherein the sheet materials are deformed by a die to form an annular deformation engaged between a head and a free end of a stem or shank of the fastener.

The deformation may comprise an annular projection or groove, or a ridge, or a plurality of dimples.

The sheets may be deformed before the fastener is set, for example by clamping the sheets together before the fastener is set. The sheets may be clamped together until the fastener has been set, or unclamped before the fastener is set. In one embodiment, the sheets are clamped together between a clamping member and a die shaped such that the sheets are deformed between the clamping member and the die. The sheets may be supported around the predetermined location by a support surface defining a recess into which the sheets are deformed by a head portion of the fastener.

Alternatively, the sheets may be deformed after the fastener is set, for example by clamping the sheets to be deformed between a clamping member and a die shaped such that the sheets are deformed between the clamping member and the die.

In a further alternative method, the sheets may be deformed and the fastener may be set simultaneously. For example, the sheets may be deformed by supporting the sheets on a die defining a recess extending around the predetermined location, a head portion of the fastener driving the sheets into the recess when the fastener is set. The sheets may be clamped against the surface of the die outside the said recess during the setting of the fastener. The fastener head may increase in thickness towards its periphery so as to define a convex surface facing the die and matching the shape of the recess formed in the die.

To enable the invention to be fully understood, a number of preferred embodiments will now be described with reference to the accompanying drawings, in which:

FIG 1 is a sectional side view showing the joining of two metal sheets using a standard semi-tubular rivet and die in a conventional manner;

FIG 2 is a similar view to that of FIG 1 showing the joining of two sheets in accordance with a first embodiment of the present invention using a standard semi-tubular rivet and a recessed die;

FIG 3 is a similar view to that of FIG 1 showing the joining of two sheets in accordance with a second embodiment of the present invention using a large headed rivet and a recessed die;

FIG 4 is a sectional side view showing the joining of two sheets where the material around the rivet head is "coined" or deformed in accordance with a third embodiment of the present invention;

FIG 5 is a similar view to that of FIG 4 showing the formation of a rib around a rivet head in accordance with a fourth embodiment of the present invention;

FIG 6 shows the formation of a rib around a rivet head in accordance with a fifth embodiment of the present invention.

FIG 7 shows the formation of a "coined" deformation under a rivet head in accordance with a sixth embodiment of the present invention; and

FIG 8 is a sectional side view of a spring-loaded upsetting die suitable for use in accordance with the present invention.

As shown in FIG 1, in a conventional method of joining metal sheets 11, 12 with a semi-tubular rivet 10, a punch (not shown) forces the rivet and metal sheets 11, 12 into a die 13 and the deformation of the metal sheet and of the shank 14 of the rivet locks the metal sheets together.

To improve the shear strength, as shown in FIG 2 and in accordance with the present invention, a rivet 110 and metal sheets 111 and 112 may be driven by a punch 115 into a die 113 where the metal sheets are deformed from the planes in which they initially lie into an annular recess 116 to form a counter-sink around a rivet head 117. The metal sheets are clamped to the die 113 by a pre-clamping head 118, that is the head 118 is applied against the sheets 111, 112 before and during rivet insertion. The sheets are deformed simultaneously with setting of the rivet.

A similar method to that of FIG 2 may be employed for large headed rivets as shown in FIG 3.

Referring now to FIG 4, a die 213 defines a wider annular recess 216 and a pre-clamping head 218 has a nose 219 which deforms metal sheets 211, 212 into the recess to form an annular deformation about a head 217 of a rivet 210, i.e. the metal sheets 211, 212 are "coined" around the rivet head 217. The pre-clamping force is sufficient to prevent relative movement between the adjacent sheets, and may be for example of the order of 1 tonne. The sheets are deformed into the recess 216 before the rivet is set. Alternatively, the "coining" of the metal sheets 211, 212 may be effected by using the head 218 to engage the metal sheets only after the rivet 210 has

been set, such that the sheets 211, 212 are fully deformed into the recess 216 after the rivet is set.

In the embodiment of FIG 5, a die 313 has an annular recess 316 spaced from a bore 320 of the die. A clamping head 318 supports a projection 318 which deforms metal sheets 311, 312 into a recess 316 to form a flush ribbing effect around a head 317 of a rivet 310 which is driven in by a punch 315. The clamping head 318 may be pressed against the metal sheets either before the rivet is driven in, after the rivet is driven in, or before and during the driving in of the rivet. This will increase the shear load strength and stiffness of the joint.

In the embodiment of FIG 6, metal sheets 411 and 412 are again formed to provide a raised annular rib about the head 417 of the rivet 410 where the die 413 has an annular protrusion (or ridge) 416 about the bore 420 of the die. The ribbing effect may be generated by a nose portion 419 which is complementary with the recess 416 on a clamping head 418. Once again, the clamping head 418 may be applied to the sheets 411, 412 before, after or during rivet setting.

Referring now to FIG 7, a die 513 has an inwardly-directed shoulder 516 in a bore 520. As a rivet 510 is set to join metal sheets 511, 512, the sheets are deformed inwardly to form an annular coining ring between a head 517 of the rivet and a shank 514 of the rivet 510. In this embodiment, the metal sheets 511, 512 are clamped to the die 513 by a clamping head 518 before a punch 515 is advanced to engage the rivet 510. Sheet deformation occurs simultaneously with rivet insertion.

As an alternative to continuous deformation about the rivet head, the metal sheets may be deformed into a series of "dimples" about the rivet head. Dimples may be of two different types, that is where a top sheet is sheared so as to be in effect cut, and where the top sheet is pressed into an adjacent sheet but is not cut.

Referring now to FIG 8, a die 613 has a fixed outer annular body 621 and an inner core 622 urged upwardly by a spring 623. The die 613 reduces the tendency to cracking of metal sheets 611, 612 as the sheets will initially be coined into a recess 616 before the deformation of the metal sheets 611, 612 by a shank 614 of a rivet 610 occurs, i.e. the deformation of the metal occurs in stages. Sheet deformation occurs primarily after rivet setting.

It is believed that the formation of deformations around a fastener such as a rivet in accordance with the present invention can increase the peel strength of a joint by of the order of 10% as well as producing significant improvements in shear strength and repeatability.

Deformation of sheets to be joined before a rivet is set not only improves joint strength but can in addition ensure that the following process of self-piercing riveting is fully isolated from any effects or reaction from the sheets surrounding the location at which the rivet is to be set. Thus whereas pre-clamping of sheets before self-piercing riveting improves joint quality as described for example in US patent 5,752,305, pre-deformation of the sheets around the site of the rivet can provide further improvements in joint quality and in particular can reduce the standard deviation of self-pierce riveted joint performance. This can be particularly important where it is difficult by simple pre-clamping of the sheets together to avoid effects from the surrounding sheets and prevents relative movements, for example when the sheets have surfaces treated with a lubricant or grease, for example when joining aluminium sheets carrying dry film die lubricant coatings.

Although it is believed desirable to pre-deform the sheets around the rivet site and to maintain a high clamping force on the sheets during rivet insertion to achieve very high quality joints, in some circumstances it is possible to release the pre-clamping force after deformation but before the rivet is driven in. The use of such a method can have advantages in particular situations as the overall assembly which supports the die against which the sheets to be riveted are clamped need not be as robust. If the clamping force is maintained during rivet insertion, the assembly must support the sum of the pre-clamping and rivet insertion forces. If the clamping force is relieved during rivet insertion, the overall assembly need only be sufficiently robust to support the larger of these two forces.

The forces necessary to deform the sheets and drive in self-piercing rivets will to an extent be a function of the physical characteristics of the sheets to be joined. With relatively thick sheets, or sheets which resist deformation, it may be necessary to use relatively high kinetic forces to achieve the necessary performance. With relatively thin sheets, or sheets which can be relatively easily deformed, the necessary

pre-clamping forces may be achieved with low velocity components driven by for example hydraulic actuators.

CLAIMS

1. A method for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location, wherein the superimposed planar sheets are placed in a fastener setting and sheet deforming assembly, and the assembly is operated to set a fastener into the sheets and to deform the sheets out of their planes around the predetermined location.
2. A method according to claim 1, wherein the sheets are deformed before the fastener is set.
3. A method according to claim 2, wherein the sheets are clamped together before the fastener is set.
4. A method according to claim 3, wherein the sheets are clamped together until the fastener has been set.
5. A method according to claim 3, wherein the sheets are unclamped before the fastener is set.
6. A method according to claim 3, 4 or 5 wherein the sheets are clamped together between a clamping member and a die shaped such that the sheets are deformed between the clamping member and the die.
7. A method according to claim 2, 3, 4, 5 or 6 wherein the sheets are supported around the predetermined location by a support surface defining a recess into which the sheets are deformed by a head portion of the fastener.

8. A method according to claim 1, wherein the sheets are deformed after the fastener is set.
9. A method according to claim 8, wherein the sheets to be deformed are clamped between a clamping member and a die shaped such that the sheets are deformed between the clamping member and the die.
10. A method according to claim 1, wherein the sheets are deformed and the fastener is set simultaneously.
11. A method according to claim 10, wherein the sheets are deformed by supporting the sheets on a die defining a recess extending around the predetermined location, a head portion of the fastener driving the sheets into the recess when the fastener is set.
12. A method according to claim 11, wherein the sheets are clamped against the surface of the die outside the said recess during the setting of the fastener.
13. A method according to claim 11 or 12, wherein the fastener head increases in thickness towards its periphery so as to define a convex surface facing the recess formed in the die.
14. An apparatus for carrying out the method in accordance with any preceding claim.
15. An apparatus for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location, the apparatus comprising an assembly which is operative to receive superimposed planar sheets and to set a fastener in engagement with the sheets and to deform the sheets around the predetermined location out of their planes either before, during or after fastener setting.

16. A rivet for use in accordance with the method of claim 1, comprising a head the thickness of which increases in the radially outwards direction to define a convex surface beneath the head.
17. A method for joining two or more sheet materials with a fastener, wherein the sheet materials are deformed by a die to form an annular deformation engaged between a head and a free end of a stem or shank of the fastener.
18. A method substantially as hereinbefore described with reference to Figure 2, 3, 4, 5, 6, 7 or 8 of the accompanying drawings.
19. An apparatus substantially as hereinbefore described with reference to Figure 2, 3, 4, 5, 6, 7 or 8 of the accompanying drawings.

1-3

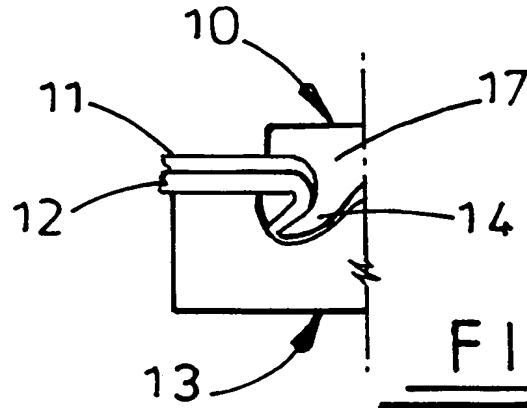


FIG. 1

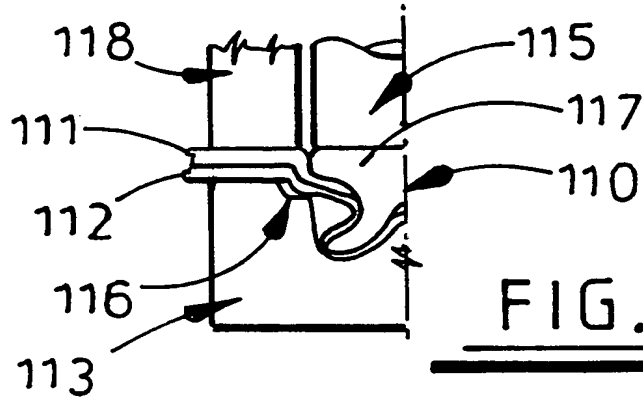


FIG. 2

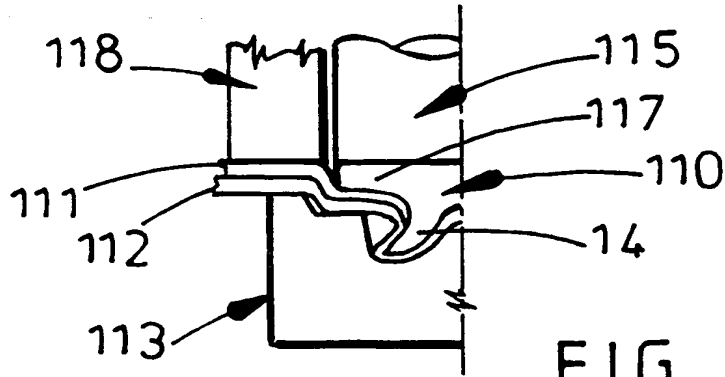
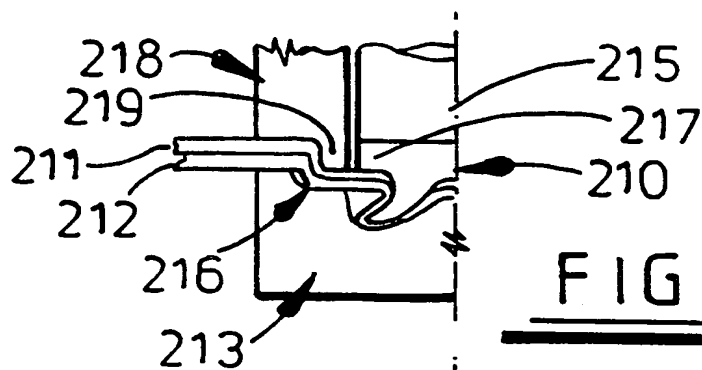
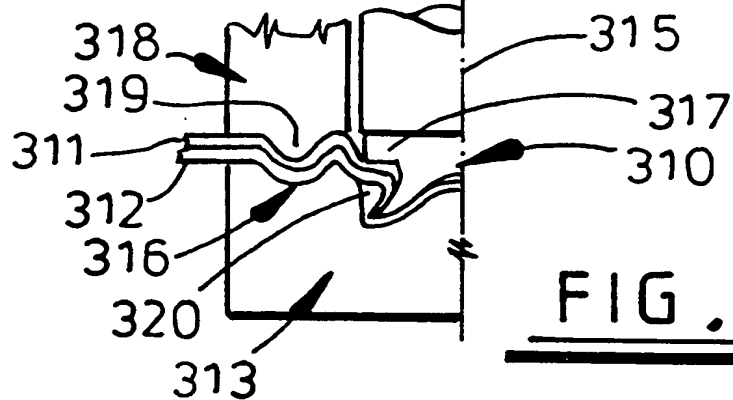
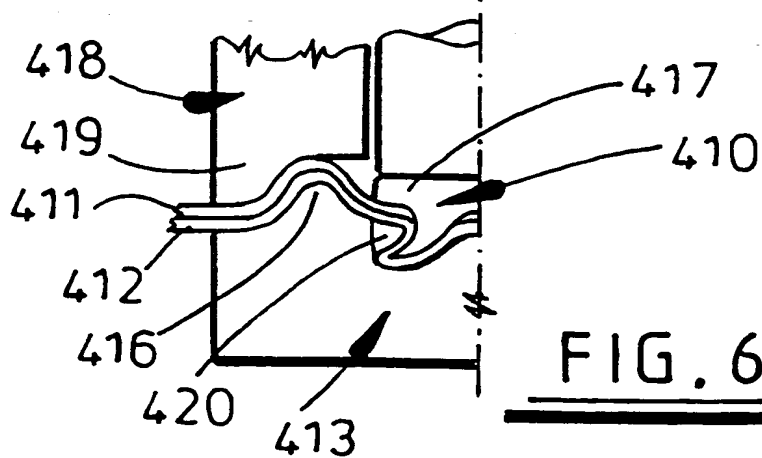
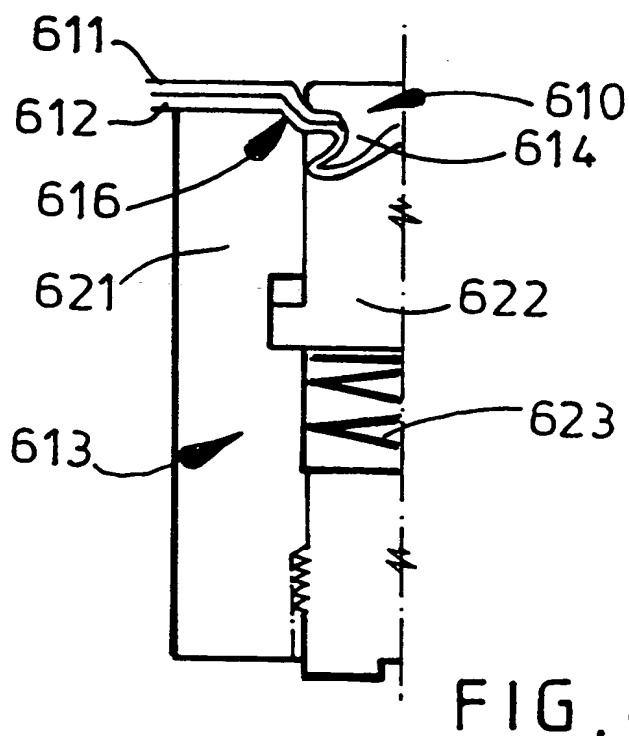
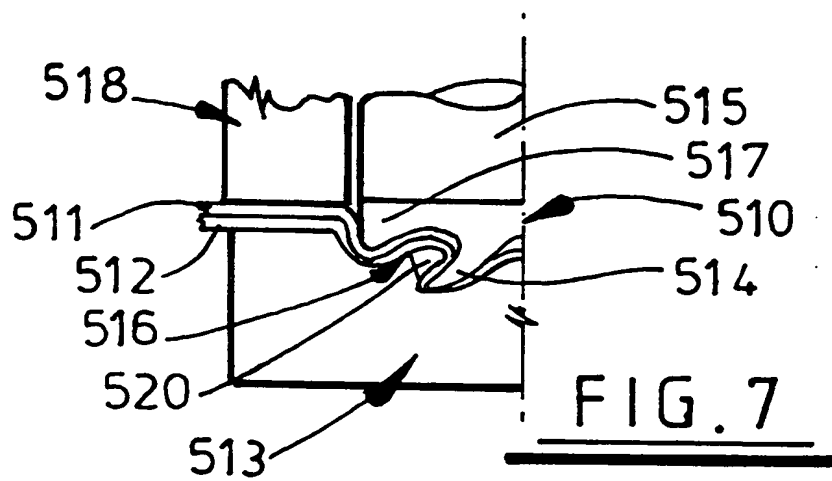


FIG. 3

2-3FIG. 4FIG. 5FIG. 6

3-3



INTERNATIONAL SEARCH REPORT

Inter: nal Application No

PCT/GB 98/02829

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B21J15/02 B21D39/03 F16B19/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B21J F16B B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 958 389 A (STANDARD PRESSED STEEL CO.) 25 May 1976	16
Y	see page 1, right-hand column, line 21-37; figure 2	13
X	DE 25 46 214 A (FURMA MANUFACTURING CO) 28 April 1977 see figures 1-5	17
X	US 2 245 933 A (MOORE, N.B.) 17 June 1941	1-12, 15
Y	see column 1, line 35-46; figures 1-3	13

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

Z document member of the same patent family

Date of the actual completion of the international search

18 January 1999

Date of mailing of the international search report

27.01.99

Name and mailing address of the ISA

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Authorized officer

Ash, R

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 98/02829

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 14, 18, 19
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
It is not possible to understand, which combination of physical features it is desired to protect by claims 14 and 19, or which combination of method steps by claim 18 (Article 6 PCT). Furthermore, claims 18 and 19 would not appear to conform to Rule 6.2(a) PCT.
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

information on patent family members

Inter: International Application No

PCT/GB 98/02829

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3958389 A	25-05-1976	CA 930991 A	31-07-1973
		CH 493750 A	15-07-1970
		CH 500391 A	15-12-1970
		CH 507458 A	15-05-1971
		DE 1910377 A	25-09-1969
		FR 2003010 A	07-11-1969
		GB 1266893 A	15-03-1972
		GB 1266894 A	15-03-1972
		IE 33278 B	15-05-1974
		NL 6903182 A	03-09-1969
		SE 364349 B	18-02-1974
		US 3551015 A	29-12-1970
DE 2546214 A	28-04-1977	NONE	
US 2245933 A	17-06-1941	NONE	

REC'D 27 JAN 2000

IPO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PJA/C088179PWO	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB98/02829	International filing date (day/month/year) 23/09/1998	Priority date (day/month/year) 23/09/1997
International Patent Classification (IPC) or national classification and IPC B21J15/02		
Applicant HENROB LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.


2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 21/04/1999	Date of completion of this report 25. 01. 00
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Ash, R Telephone No. +49 89 2399 2361



**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB98/02829

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-6 as originally filed

Claims, No.:

1-16 as received on 08/10/1999 with letter of 08/10/1999

Drawings, sheets:

1/3-3/3 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☒ the claims, Nos.: 17-19
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

- ☐ the entire international application.
☒ claims Nos. 15.

because:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB98/02829

- ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):
- ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
- ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.
- ☒ no international search report has been established for the said claims Nos. 15.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1,14,16
	No:	Claims	2-13
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-14,16
Industrial applicability (IA)	Yes:	Claims	1-14,16
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB98/02829

1. In accordance with Rule 70.2(d) PCT no opinion will be given with regard to whether the subject-matter of claim 15 meets Article 33 PCT, because the subject-matter of this claim has not been searched. None of the originally filed claims related to a rivet which comprises a head, the thickness of which increases **continually** in the radially outward direction.
2. The broadest claim is claim 16, so this will be addressed first. The subject-matter of this claim lacks novelty (Article 33(2) PCT).

From DE-A-2 546 214 (=D2), Figures 1 to 5, a method of joining two or more sheet materials (32, 33) with a fastener (34) is known, wherein the sheet materials are deformed by abutment with a die surface (25) to form an annular deformation engaged between a head and a free end of a stem or shank of the fastener (see Figure 5).

3. Independent claim 1 does not include any new subject-matter (Article 33(2) PCT).

Document US-A-2 245 933 (=D3) discloses a

A method for joining together two or more superimposed generally planar sheets (3,4) by setting a fastener (1) in engagement with the sheets at a predetermined location, wherein the superimposed planar sheets are placed in a fastener setting and sheet deforming assembly, and the assembly is operated to set a fastener into the sheets and to deform all the sheets out of their planes around the predetermined location (see column 1, lines 35 to 46).

4. Dependent claims 2 to 13 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT with respect to novelty and/or inventive step (Articles 33(2) and (3) PCT).
- 4.1 The additional features of claims 2 to 12 do introduce anything other than simple method steps, which the skilled man would perform at his discretion, without an inventive step being required.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB98/02829

4.2 Document **US-A-3 958 389 (=D1)** discloses on page 1, right-hand column, lines 21 to 37 the advantages of providing a recess under the head of the rivet. For the skilled man starting from D3 it would be obvious to apply the teaching of D1 to realise these advantages. In this way he would arrive at the subject-matter of claim 13 without exercising an inventive step.

5. Independent claim 14 lacks novel subject-matter compared to D3 (Article 33(2) PCT).

5.1 From D3, the following features are known in combination:

An apparatus suitable for joining together two or more superimposed generally planar sheets by setting a fastener in engagement with the sheets at a predetermined location, the apparatus comprising an assembly which is operative to receive superimposed planar sheets and to set a fastener in engagement with the sheets and to deform all the sheets around the predetermined location out of their planes either before, during or after fastener setting.

6. The claims meet neither Rule 6.2(b) nor 6.3(b) PCT.

7. The description does not meet Rule 5.1(a)(ii) PCT, because documents D1 to D3 are not cited therein.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 98/02829

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B21J15/02 B21D39/03 F16B19/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B21J F16B B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 958 389 A (STANDARD PRESSED STEEL CO.) 25 May 1976	16
Y	see page 1, right-hand column, line 21-37; figure 2	13
X	DE 25 46 214 A (FURMA MANUFACTURING CO) 28 April 1977 see figures 1-5	17
X	US 2 245 933 A (MOORE, N.B.) 17 June 1941	1-12, 15
Y	see column 1, line 35-46; figures 1-3	13

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

Z document member of the same patent family

Date of the actual completion of the international search

18 January 1999

Date of mailing of the international search report

27.01.99

Name and mailing address of the ISA

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Fax: (+31-70) 340-3016

Authorized officer

Ash, R

INTERNATIONAL SEARCH REPORT

Int. application No.
PCT/G8 98/02829

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 14,18,19
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
It is not possible to understand, which combination of physical features it is desired to protect by claims 14 and 19, or which combination of method steps by claim 18 (Article 6 PCT). Furthermore, claims 18 and 19 would not appear to conform to Rule 6.2(a) PCT.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/GB 98/02829

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